PLATE 1

Interim Geologic Map - Santa Clara Quadrangle

Open-File Report 339 December 1996

UTAH GEOLOGICAL SURVEY

a division of

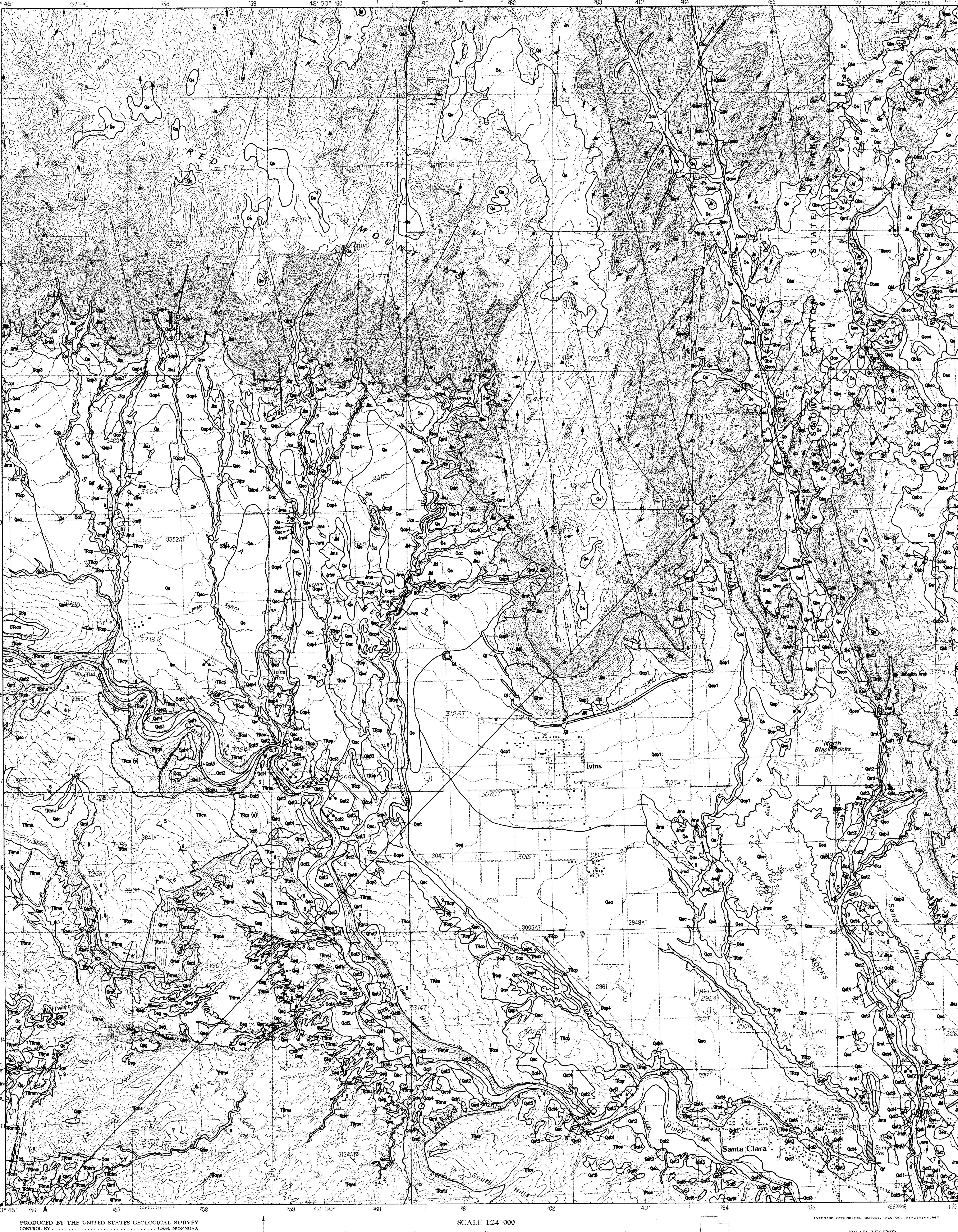
Utah Department of Natural Resources

in cooperation with

U.S. Geological Survey

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SANTA CLARA QUADRANGLE
UTAH-WASHINGTON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY . . . . USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN 1978
FIELD CHECKED . . . . 1979 MAP EDITED 1986
PROJECTION . . . . LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR . . . . ZONE 12
10,000-FOOT STATE GRID TICKS . . . . . . UTAH, SOUTH ZONE
UTM GRID DECLINATION . . . . 1°37' WEST
1986 MAGNETIC NORTH DECLINATION . . . . . . 14° EAST
VERTICAL DATUM . . . . . NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM . . . . . . 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (6 meters north and 70 meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

Where omitted, land lines have not been established

All marginal data and lettering generated and positioned by automated type placement procedures

NORTH

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. 2

SCALE 1:24 000

MILES 1 5 0 1

FEET 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000

KILOMETERS 1 5 0 1 2

METERS 1000 0 1000 2000

CONTOUR INTERVAL 40 FEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092

UTAH

QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

1 Gunlock
2 Veyo
3 Saddle Mountain
4 Shivwits
5 Washington
6 Jarvis Peak
7 White Hills
8 St George

ADJOINING 7.5' QUADRANGLE NAMES

INTERIOR-GEOLOGICAL SURVEY, RESTON, VIRGINIA-1987

ROAD LEGEND

Improved Road . . . .
Unimproved Road . . . .
Trail . . . .

Interstate Route U.S. Route State Route

SANTA CLARA, UTAH
PROVISIONAL EDITION 1986

37113-B6-TF-024

Utah Geological Survey
Department of Natural Resources
In cooperation with the
U.S. Geological Survey

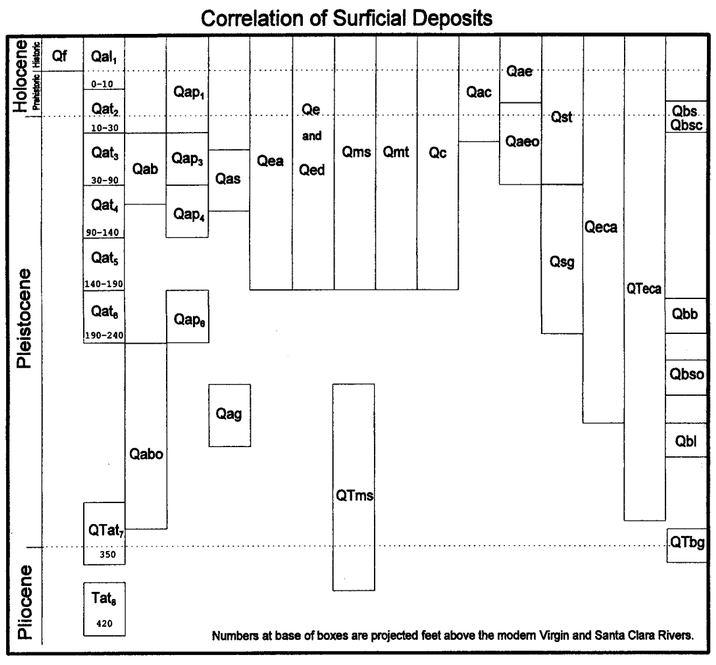
Interim Geologic Map of the Santa Clara Quadrangle, Washington County, Utah

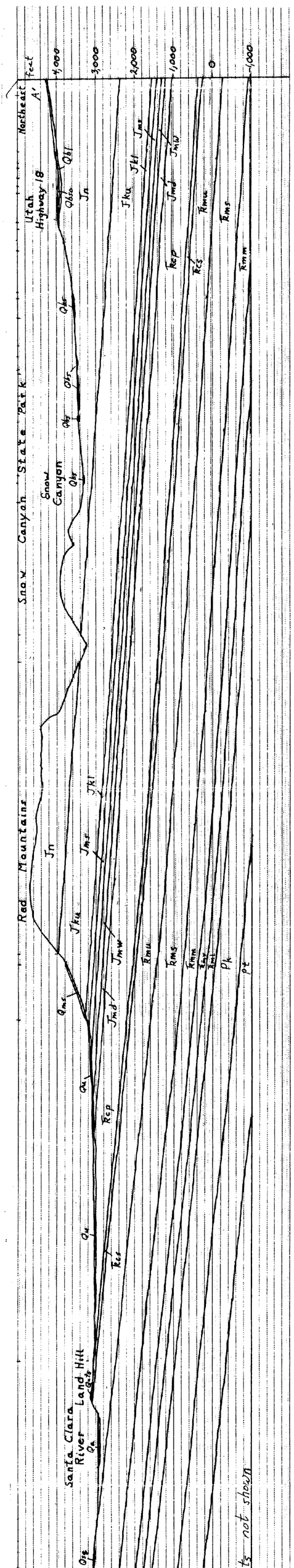
by
Grant C. Willis and Janice M.Higgins

1996

Plate 2
Utah Geological Survey Open-File Map 339
Geologic Map of the Santa Clara Quadrangle

Correlation of Surficial Deposits

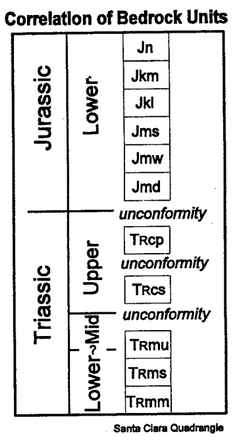


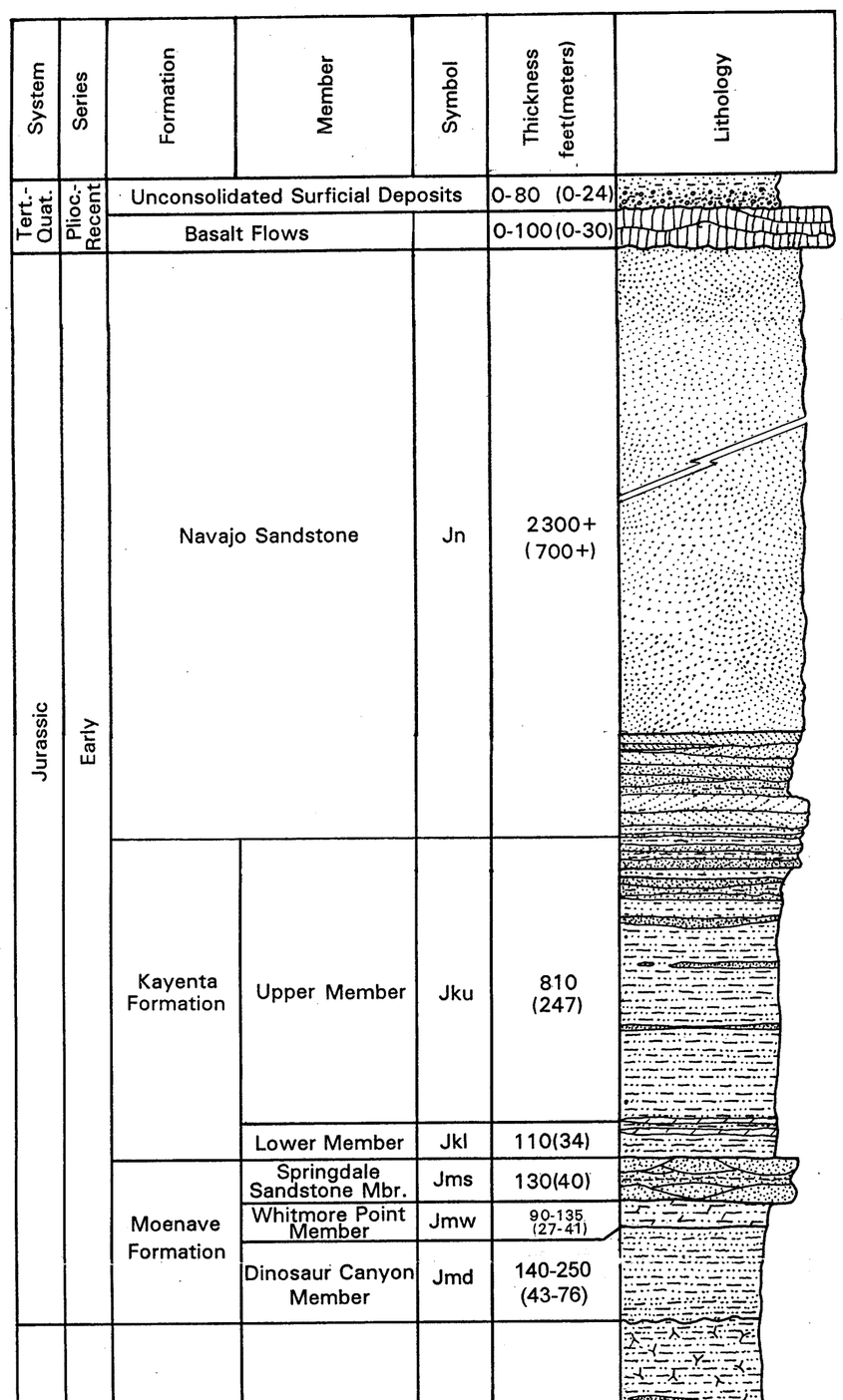


Key to Map Symbols

- Contact
- High-angle fault -- dashed where approximately located, dotted where concealed, bar and ball on down-thrown side
- Gravity slide detachment -- (s) denotes bedrock units deformed by bedding plane sliding
- Lineament -- mapped from aerial photographs
- Axial trace of folds -- dotted where concealed, arrows on trace show direction of plunge
  - Anticline
  - Syncline
- Strike and dip of bedding
  - Inclined
- Strike and dip of joints
  - Inclined
  - Near-vertical
- Gravel or road-fill pit
- Spring
- Rock arch
- Basalt dike -- arrow shows direction of dip

Correlation of Bedrock Units





Description of Map Units

QUATERNARY-LATE TERTIARY

Qu **Undifferentiated surficial deposits** -- shown on cross section only.

Human-made deposits

Qf **Artificial fill** -- Material emplaced for the contruction of dams and dikes.

Alluvial Deposits

Qal_1 **Young alluvial-stream deposits** -- Moderately to well-sorted clay to small gravel deposits in large, well-graded drainages; includes terrace deposits up to 10 feet (3 m) above current channels; 0-20 feet (0-6 m) thick.

Qat_{2-6}, $QTat_7$, Tat_8
Stream-terrace deposits -- Gravel- to cobble-size clasts in a muddy to coarse sand matrix; generally well-sorted; clasts are well-rounded and many are exotic to the quadrangle, indicating sources several miles upstream; older deposits are capped by thick pedogenic carbonate (caliche); subscripts denote relative heights (and relative ages by inference--see text figure 7) above the modern Santa Clara River: level 2 deposits are 10-30 feet (3-9 m) above the river; level 3 deposits are 30-90 feet (9-27 m); level 4 are 90-140 feet (27-43 m); level 5 are 140-190 feet (43-58 m); level 6 are 190-240 feet (43-73 m); level 7 are about 350 feet (107 m); and level 8 are about 420 feet (128 m); levels 2 and 3 are extensively cultivated in the Santa Clara area; 0-30 feet (9 m) thick.

Qab, Qabo
Boulder-terrace deposits -- Poorly to moderately sorted mud- to small boulder-sized materials deposited in terraces along small washes; clasts are mostly basalt but include some sedimentary and intrusive igneous rocks derived from outcrops north and northeast of the quadrangle; younger deposits (Qab) are mapped in the SE 1/4, section 21, T. 41 S., R. 16 W., and are 10-20 feet (3-6 m) above the Santa Clara flow; older deposits (Qabo) are mapped on the bench near the east quadrangle boundary, and are 10 to 40 feet (3-12 m) above the level of active washes on the bench; most Qabo deposits are older than the Snow Canyon Overlook flow; 10-30 feet (3-9 m) thick.

$Qap_{1,3,4,8}$ **Pediment-mantle deposits** -- Poorly sorted, angular to subrounded clasts ranging in size from gravel to large boulders with abundant fine-grained matrix; derived locally from the upper Kayenta Formation and Navajo Sandstone; commonly partially covered by scattered eolian sand deposits; mantle broad benches in the central part of the quadrangle; numbers roughly correlate with alluvial terrace levels, but heights above drainages are only valid near the Santa Clara River and larger tributaries since small drainages are not well-graded to the local base level; up to 80 feet (24 m) thick.

Qas, Qag
Fine- (Qas) and coarse-grained (Qag) deposits beneath and between basalt flows -- Small isolated remnants of poorly to moderately sorted clay- to boulder-sized alluvial materials locally exposed beneath and between basalt flows; locally includes eolian sand; fine-grained deposits are silt, sand, clay, and pebble gravels, and are mapped at the base of the Santa Clara flow near Santa Clara; coarse-grained deposits are cobble- to small-boulder-gravel in a poorly sorted matrix and are mapped between the Lava Ridge and Snow Canyon Overlook flows in the northeast part of the quadrangle; 0-20 feet (0-6 m) thick.

Colluvial Deposits

Qc **Colluvial deposits** -- Poorly sorted, angular to rounded, clay- to boulder-sized material deposited on moderate slopes; lacks well-defined drainage pattern; deposited by sheet wash, debris flow, and slope-creep processes; locally includes talus, eolian, and alluvial deposits; 0-30 feet (0-18 m) thick.

Eolian Deposits

Qe, Qed **Eolian sand** -- Well- to very well-sorted, fine- to very fine-grained, well-rounded, mostly quartz sand; the sand is primarily from the Navajo Sandstone; commonly deposited as a thin cover or in irregular hummocky mounds; 0-20 feet (0-6 m) thick; in lower Snow Canyon eolian sand is mounded into poorly developed dunes (Qed); 0-50 feet (0-15 m) thick.

Mass-Movement Deposits

Qms **Slump and landslide deposits** -- Very poorly sorted clay- to boulder-size debris in chaotic, hummocky mounds; involves colluvium, talus, basalt flows, and bedrock units; basal detachments are developed on Petrified Forest Member of Chinle Formation, upper red member of Moenkopi Formation, and upper part of Kayenta Formation; Red Mountain slump north of Ivins involves large, partially intact block of Navajo Sandstone; thickness highly variable.

QTms **Old landslide deposits** -- Very poorly sorted boulder- to clay-sized debris in chaotic mounds; caps ridges and knolls that are over 400 feet (120 m) above drainages in southwest part of quadrangle; some boulders are in excess of 30 feet (9 m) across; blocks were derived primarily from the Shinarump Conglomerate; 20-80 feet (6-24 m) thick.

Qmt **Talus deposits** -- Very poorly sorted, angular boulders with minor fine-grained interstitial materials; deposited on and at the base of steep slopes; 0-20 feet (0-6 m) thick.

Spring Deposits

Qst **Spring Tufa** -- Pale-gray, pale-yellowish-gray, or pale-reddish-gray, calcareous tufa; weathers to form small punky mounds; caps small hills and knobs, or drapes down slopes; typically less than 10 feet (3 m) thick.

Mixed-Environment Deposits

Qac **Alluvial and colluvial deposits** -- Poorly to moderately sorted clay- to boulder- sized material in minor drainages; gradational with colluvial deposits; locally includes colluvial, talus, terrace, and minor eolian deposits too small to map separately; 0-20 feet (0-6 m) thick.

Qae, Qaeo
Alluvial and eolian deposits -- Moderately to well-sorted sand with minor clay, silt, cobbles, and boulders; includes abundant eolian and reworked eolian sand; deposited in large, flat-bottom canyons and washes; older deposits (Qaeo) are dissected 10-30 feet (3-9 m) by downcutting washes; 0-30 feet (0-9 m) thick.

Qea **Eolian and alluvial deposits** -- Well-sorted eolian sand with minor alluvial clay, silt, sand, and gravel; similar to eolian sand deposits (Qe) but with larger alluvial component; generally has thick pedogenic carbonate cap; accumulates on flat areas that have been protected from erosion for long periods of time; 0-20 feet (0-6 m) thick.

Qeca, QTeca
Eolian and alluvial deposits with thick carbonate soil on basalt flows -- Eolian clay, silt, and sand, and alluvial gravel deposited on basalt flows; alluvial deposits are typically at base of deposit, and are capped by very thick pedogenic carbonate soil; older deposits (QTeca) are mapped on the Gunlock lava flow and part may be latest Tertiary in age; 0-20 feet (0-6 m) thick.

Qsg **Gypcrete and alluvial gravel** -- Pale-gray gypcrete; basal part locally includes poorly to moderately stratified, moderately sorted, lenticular channel deposits of silt, sand, clay, cobbles, and boulders; gypcrete forms a resistant ledge; alluvial deposits form a steep slope; present only on the highly gypsiferous Moenkopi Formation; gypcrete ledge is as much as 10 feet (3 m) thick; channel deposits are as much as 80 feet (24 m) thick.

Basalt Lava Flows and Cinder Cones

Qbs, Qbsc
Santa Clara lava flow and cinder cone -- Dark-brownish-black to black, subalkaline basalt flow (Qbs) and cinder cone (Qbsc); rocks have abundant small olivine phenocrysts in an aphanitic groundmass; flows have very jagged aa surface; cinder cone has youthful symmetrical appearance; flow is 10-30 feet (3-9 m) thick, but locally thickens to 60 feet (18 m); estimated 10,000-20,000 years old.

Qbb
Big Sand lava flow -- Dark-reddish-gray to dark-brownish-gray, quartz-bearing, basaltic trachyandesite; has large plagioclase and quartz, and small olivine phenocrysts; has abundant "rafts" of scoria in upper part of lava flow; capped by thick pedogenic carbonate soil; typically 10-40 feet (3-12 m) thick; age poorly constrained but estimated at 0.75 to 1.2 million years.

Qbso **Snow Canyon Overlook lava flow** -- Very dark-brown to brownish-black, trachybasalt with small phenocrysts of clinopyroxene and olivine; dense, brittle, and strongly jointed; typically 10-30 feet (3-9 m) thick; age not determined but it overlies the Lava Ridge flow and is probably less than 1.5 million years old; it may correlate with the Cedar Ridge flow dated at 1.2+-0.1 Ma (Best and others, 1980; Willis and Higgins, 1995).

Qbl **Lava Ridge lava flow** -- Moderate- to dark-gray to moderate-brownish-gray, quartz-bearing, basaltic trachyandesite; has large plagioclase and quartz, and small olivine phenocrysts; age is poorly constrained, but may correlate with the Middleton flow in the St. George quadrangle, which was dated at 1.5±0.1 Ma (Best and others, 1980; Higgins and Willis, 1995).

QTbg **Gunlock lava flow** -- Dark-gray to dark-brownish-gray alkali olivine basalt; abundant small olivine phenocrysts; crudely columnar jointed; present only near west side of quadrangle; dated at 1.6±0.1 Ma (Hintze and Hammond, 1994).

unconformity

JURASSIC

Jn **Navajo Sandstone** -- Massive, cross-bedded quartz sandstone; color varies from moderate-reddish-brown in the lower part to very pale-yellowish-gray in the upper part; color changes are discordant to bedding and cross bedding; sand grains are well-rounded, fine- to medium-grained, and frosted; forms cliff in Snow Canyon; forms rubbly slopes and ledges where highly fractured; main part has eolian origin; lower few hundred feet are dominantly planar bedded with crinkle bedding, salt casts, and teepee structures that formed as eolian sand was blown into a sabkha and reworked by evaporite mineral growth; over 2,300 feet (700 m) thick.

Jku **Upper member of the Kayenta Formation** -- Interbedded reddish-brown siltstone, purplish-red to reddish-brown mudstone, and fine-grained, calcareous, slightly mottled sandstone; punky gypsum is common in some intervals near the base; cross-cutting gypsum stringers are common; generally coarsens upward and has abundant planar sandstone ledges in upper part; forms slopes and small ledges; 810 feet (247 m) thick.

Jkl **Lower member of the Kayenta Formation** -- Pale-reddish-brown to moderate-reddish-brown, thin-bedded siltstone and very fine-grained, planar- to lenticular-bedded sandstone, interbedded with moderate-purplish-red mudstone; upper contact mapped on top of upper of three thin beds of light-pinkish-gray to light-olive-gray dolomite 2-6 inches (5-15 cm) thick; 110 feet (34 m) thick.

Jms **Springdale Sandstone Member of the Moenave Formation** - Pale-reddish-brown to grayish-yellow, fine- to medium-grained, cross-bedded sandstone with interbedded light-purplish-gray siltstone near the middle; weathers to rounded ledges; up to 130 feet (40 m) thick.

Jmw **Whitmore Point Member of the Moenave Formation** -- Greenish-gray claystone interbedded with pale-brown to pale-red, thin-bedded siltstone with several 2-6 inch- (5-15 cm-) thick beds of light-greenish-gray dolomitic limestone that contain algal structures and fossil fish scales and bone fragments of *Semionotus kanabensis* (Hamilton, 1984); nonresistant and poorly exposed; 90-135 feet (27-41 m) thick.

Jmd **Dinosaur Canyon Member of the Moenave Formation** -- Interbedded, moderate-reddish-brown siltstone and fine-grained, thin-bedded, pale-reddish-brown to grayish-red sandstone with laminated cross-beds; forms slope; similar in color and weathering pattern to the upper member of the Kayenta Formation; 140 feet (43 m) thick.

unconformity

TRIASSIC

T_Rcp **Petrified Forest Member of the Chinle Formation** -- Light-brownish-gray to grayish-purple bentonitic shale and siltstone with several interbeds of pale-yellowish-brown, cross-bedded sandstone up to 10 feet (3 m) thick; locally has petrified wood; shale weathers to a "popcorn" surface with abundant mudcracks due to bentonitic clay swelling and shrinking with moisture; forms a well-developed strike valley adjacent to the more resistant cliffs of the Shinarump Conglomerate Member; 700 feet (213 m) thick.

unconformity

T_Rcs, $T_Rcs(s)$
Shinarump Conglomerate Member of the Chinle Formation -- Varies from a grayish-orange to moderate-yellowish-brown, medium- to coarse-grained sandstone with locally well-developed limonite bands ("picture rock"), to a moderate- to dark-reddish-brown, chert-pebble conglomerate; forms a very resistant cuesta ledge; deposited in stream-channels; locally has hummocky upper surface where involved in gravity slumping --$T_Rcs(s)$; ranges from 50-200 feet (15-61 m) thick.

unconformity

T_Rmu **Upper red member of the Moenkopi Formation** -- Moderate-reddish-brown, thin-bedded siltstone and sandstone with some thin gypsum beds and abundant discordant gypsum stringers; locally contains a few thick- to massive-bedded, ledge-forming, channel sandstone beds; ripplemarks common in the siltstone; forms a slope with a few ledges; 500 feet (152 m) thick.

T_Rms **Shnabkaib Member of the Moenkopi Formation** -- Banded, light-gray to pale-red ("bacon-stripe"), gypsiferous siltstone, bedded gypsum, and mudstone; several thin interbeds of dolomitic, unfossiliferous limestone near the base; has two to three prominent thin beds of moderate-reddish-brown siltstone; parts weather to a gypsiferous, powdery soil; forms a valley except where held up by more resistant overlying units; 700 feet (213 m) thick.

T_Rmm **Middle red member of the Moenkopi Formation** -- Interbedded moderate-red to moderate-reddish-brown siltstone, mudstone, and thin-bedded sandstone; forms a slope and is generally not well exposed; 400 feet (122 m) thick.

Subsurface Units -- Shown on Cross Section Only

T_Rmv **Virgin Limestone Member of the Moenkopi Formation**

T_Rml **Lower red, Timpoweap, and Rock Canyon Conglomerate members of the Moenkopi Formation**

unconformity

PERMIAN

Pk **Kaibab Formation (Harrisburg and Fossil Mountain Members)**

Pt **Toroweap Formation**

Pq **Queantoweap Sandstone**

Pp **Pakoon Dolomite**

PENNSYLVANIAN

IPc **Callville Limestone**